Building Energy Simulation

User News

For Users of DOE-2, SPARK, BLAST and their Derivatives

What's New??

■ ***User News* on the WWW** You can view this newsletter on the web. Go to url

http://eande.lbl.gov/BTP/SRG/UNEWS

Download the newsletter PDF format and read it with Adobe's "Acrobat" reader, available free of charge.

■ **EnergyBase** Is the new name for the "Best of DOE-2 and BLAST" program. Read about it on p. 28.

■ **Three Cheers for Hong Kong!!** Dr. Sam Hui of the DOE-2 Resource Center in Hong Kong has published a terrific web page at

http://arch.hku.hk/research/BEER/doe2/doe2.htm

Thanks for all the hard work, Sam!

■ **Free DOE-2 Help** Call or fax our modeling expert, Bruce Birdsall, for questions about DOE-2. If you need to fax an example of your problem, please telephone him beforehand. This free service is supported by LBNL's Simulation Research Group. Phone Bruce at (510) 829-8459 between the hours of 10 a.m. and 3 p.m. PST.

■ **MicroDOE2** Is now available from Acrosoft/CAER Engineering of Denver, Colorado. Details are on p. 17.

■ ***Home Energy* Magazine** Our friends at *Home Energy* (the magazine of residential energy conserva-
tion) have a new url at
http://www.homeenergy.org/

What's Inside??

The *User News* is published by the Simulation Research Group at LBNL with cooperation from the BLAST Support Office at the University of Illinois.

Direct comments or submissions to Kathy Ellington, Editor, MS: 90-3147, Lawrence Berkeley National Laboratory, Berkeley, CA 94720, or email kathy@gundog.lbl.gov or send us a fax at (510) 486-4089. Direct BLAST-related inquiries to the BLAST Support Office, phone (217) 333-3977, send email to support@blast.bso.uiuc.edu ☺☺☺ 10/96 2000 This work was supported by the Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Building Technology, State and Community Programs, Office of Building Systems of the U.S. Dept. of Energy, under Contract No. DE-AC03-76SF00098. Energy and Environment Division, Lawrence Berkeley National Laboratory, University of California, Berkeley, California 94720 USA

Using DOE-2 to Study Apartment Indoor Temperatures During the July 1995 Chicago Heat Wave

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Although DOE-2 is generally used to analyze building energy consumption, it can also be used to evaluate thermal conditions in buildings without air-conditioning. This article describes the use of DOE-2 to investigate conditions in apartment buildings during the July 1995 Heat Wave in Chicago, and determine to what degree the poor thermal characteristics and improper operations of the buildings might have contributed to the death toll.

The July 1995 Chicago Heat Wave created a great deal of human discomfort and, by latest estimates, increased deaths in Cook County by over 700 over a five day period. Epidemiological studies have uncovered a number of socio-economic, cultural, institutional, and physiological factors, but the role of the building and its interior conditions have been largely unexamined.

Studies of mortality during heat waves have found a heat index threshold above which deaths increase rapidly, and that the duration of the heat wave, increased humidity, high minimum temperatures, and low wind speeds all contribute to increased deaths. There is also typically a one-day time lag between the peaks in the heat index and deaths. In the recent Chicago Heat Wave, most of the victims were older, infirm residents living on the top floors of inner-city apartments with no air-conditioning.

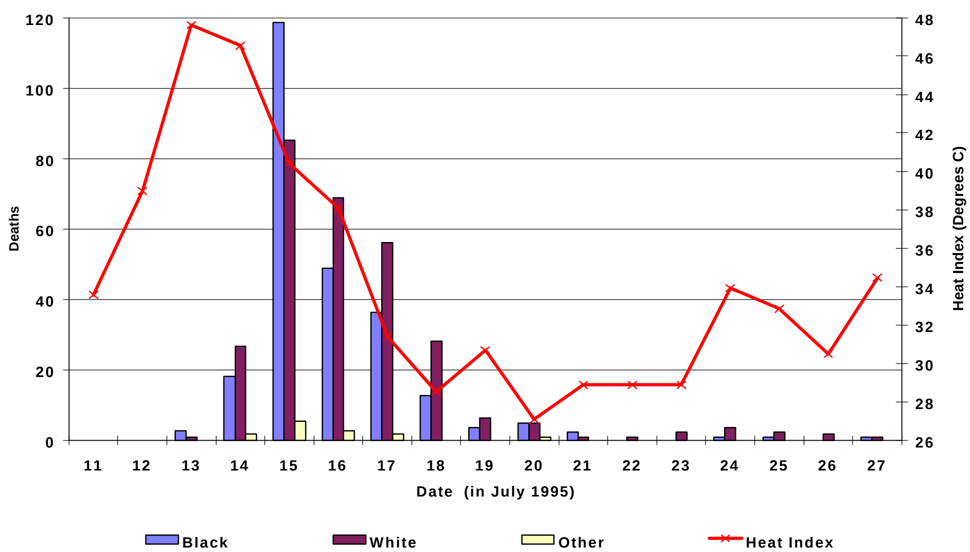


Figure 1: Chicago July 1995 Heat Storm's Fatal Impacts (source : *Global Change,* February 1996)

To researchers in building physics, such weather and building conditions are characteristically those that would produce abnormally high indoor temperatures. This was confirmed through DOE-2 simulations of four prototypical apartment buildings of different vintages (pre-1940s, 1960s, 1970s, and 1980s) with building characteristics and conservation levels based on the Residential Energy Consumption Survey (RECS) for multi-family buildings in the North Central Region.

DOE-2 was used to simulate indoor conditions in the prototypical apartment buildings during the July 1995 Heat Wave in the absence of air-conditioning, first with the windows closed, and then opened for ventilation whenever outdoor temperatures were lower. To study the benefits of potential conservation strategies, the simulations were repeated with additional ceiling insulation, light-colored roofs, and lowered window shading coefficients.

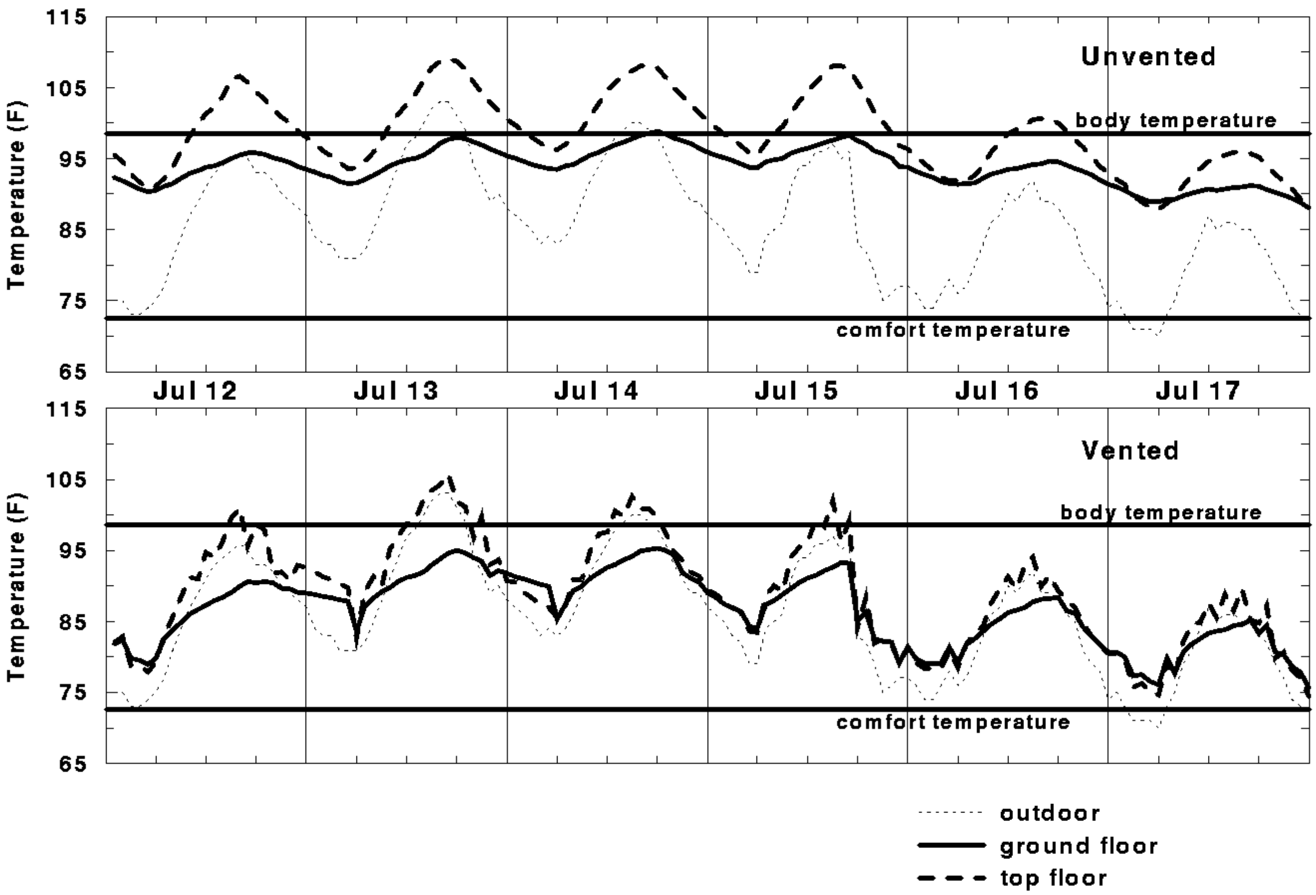


Figure 2: DOE-2-calculated Indoor temperatures in a typical 1940's apartment building in Chicago during the July 1995 Heat Wave

The results are presented as plots of temperature history or temperature and humidity on a psychrometric chart (see Figures 2 and 3). If the buildings were unventilated, as often reported as the case, the indoor temperature would reach as high as 108F on the top floors of the pre-1940s buildings and above human body temperature 80 percent of the time over the peak three days. Conditions in the 1970s apartment building would be even worse, with the *average temperature* of 108F over the same three-day period! Due to their greater mass and insulation, these buildings would remain hot for days after the peak air temperatures had already passed.

The simulations show that the single most important strategy to prevent excessive overheating during a heat wave is ventilation. Under such conditions ventilation would not make the buildings comfortable but would prevent them from acting like solar ovens and keep temperatures indoor close to or below that outdoors. In older, un-insulated buildings, adding ceiling insulation and lightening the roof color would have an appreciable impact on improving conditions in top floor apartments. However, in newer buildings weatherization would make minimal impact.

The prevention or reduction of mortality during an intense heat wave should be viewed as a form of disaster control. Due to the public outcry over the 1995 Heat Wave, the city of Chicago has announced a plan in the case of future heat waves, but the plan so far focuses on providing warnings, checking on residents, and moving people to a "cool room". This preliminary study suggests the dangers can also be lessened by improving the thermal conditions and operation of the buildings.

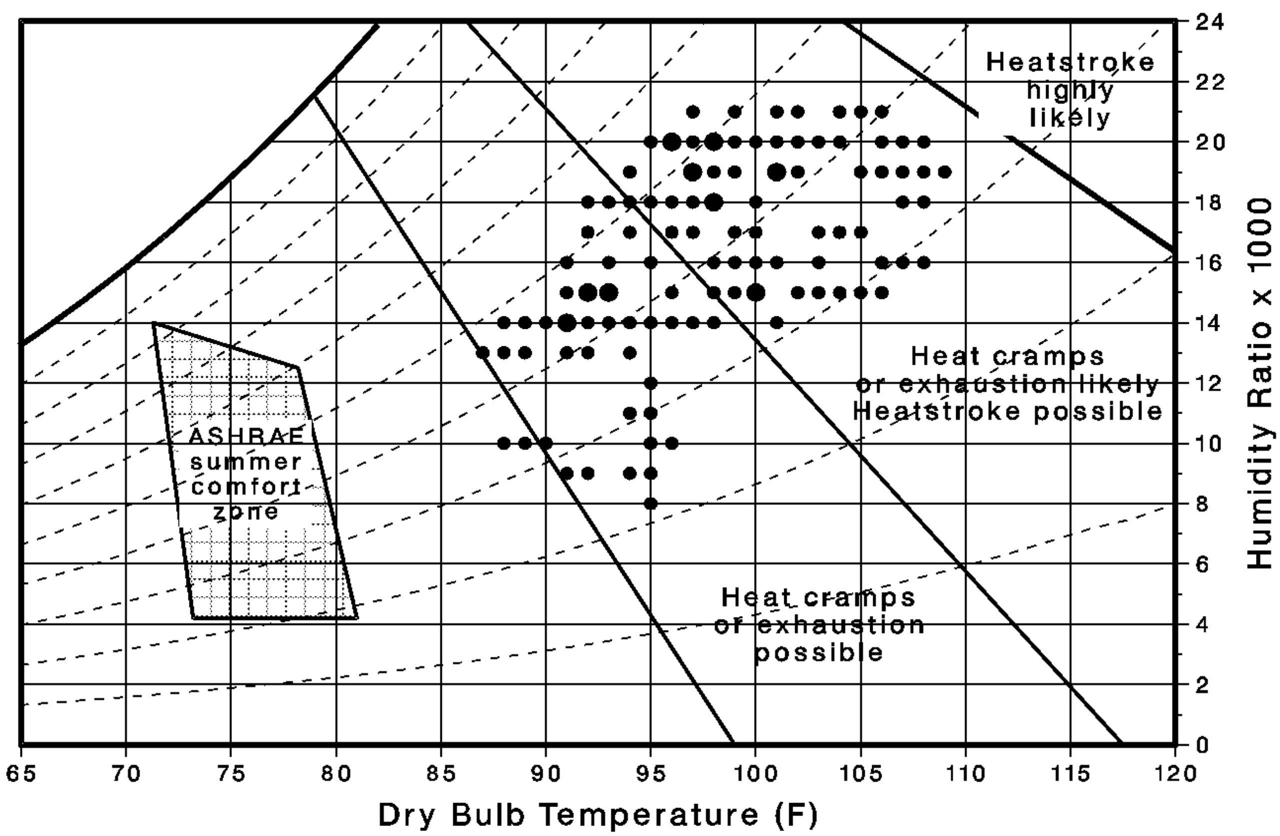
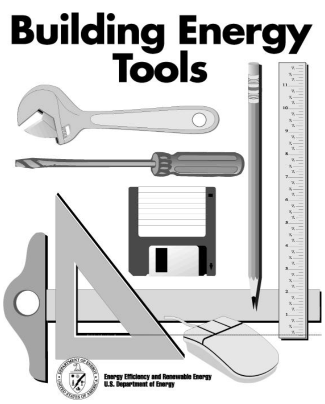


Figure 3: Psychrometric plot of DOE-2 calculated indoor temperatures on top floor of unventilated 1940's apartment in Chicago during the July 1995 Heat Wave

References

1. "Heat waves take heavy toll on urban poor", in *Global Change*, February 1996.
2. L.S. Kalkstein, "A new approach to evaluate the impact of climate on human mortality," in *Environmental Health Perspectives*, 96:145-150.
3. Y.J. Huang 1995. "DOE-2 analysis of indoor temperatures in typical apartment buildings during the July 1995 Chicago summer Heat Wave," office memorandum, Lawrence Berkeley National Laboratory.
4. Y.J. Huang and J. Melbourne 1996. "Building science aspects of urban heat catastrophes," poster presentation, 1996 ACEEE Summer Study, Asilomar CA.



A directory of *Building Energy Tools* is now available from the U.S. Department of Energy on the World-Wide Web. The first version of the directory includes almost 50 tools—from research grade software to commercial products with thousands of users. The common thread for all the tools is that they provide building-related information for improving energy efficiency or incorporating renewable energy concepts. Many of the tools in the first version, at some point in their life-cycle, were sponsored by DOE. A limited number of copies of the directory will be reprinted later this fall. Contact Dru Crawley if you would like to obtain a copy (address below).

The directory is already available on the world wide web at

http://www.eren.doe.gov/buildings/toolsdir.htm

where it will be kept updated and expanded. In the future, we will also provide information about DOE energy tools research [DOE-2, BLAST, EnergyBase (DOE-2/BLAST merger), SPARK, Building Design Advisor, Softdesk Energy, Energy-10, and the Industry Alliance for Interoperability].

If you know of other tools that should be included in the web directory, please let us know.

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U. S. Department of Energy

Two-Dimensional Wall Response Factors

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The use of steel-frame construction in recent years has increased the need for building energy simulation programs such as DOE-2 to model two-dimensional heat flows in such wall systems. Two-dimensional heat flows are significant in steel-frame and concrete-block construction, and affect both their conductance and thermal mass characteristics.

The Efficiency Technology Office of the California Energy Commission requested that the authors generate a library of two-dimensional response factors for 76 steel-frame wall sections for use with the DOE-2 program for building energy use analysis. These response factors were calculated using WALFERFN (Wall Finite-Element Response Factor, New Version), an in-house utility program developed at LBNL in 1987 for this application.

WALFERFN was adapted from subroutines originally written for a developmental version of DOE-2.1B for modeling heat conduction through the building foundation (Bull et al. 1981). These subroutines were modified in WALFERFN as a stand-alone program that reads a simple input file for a wall section, computes one-dimensional equivalent response factors for two-dimensional heat flows, and writes the results into a BDLLIB.BIN library file. WALFERFN was used in several previous LBNL projects, notably ASHRAE Special Project 53 in support of the U.S. Department of Energy’s voluntary residential building energy standards (Huang et al., 1987, 1988). Tests have shown that WALFERFN response factors are consistent with DOE-2 for one-dimensional layers. Recent comparisons by Jan Kosny (of Oak Ridge National Laboratory) also indicate that WALFERFN results for two stee-frame constructions agreed with ORNL results to within 3 percent.

WALFERFN consists of two programs, WALLGEN and FERFG. WALLGEN reads the input file and automatically generates a finite-element grid depending on user-specified thicknesses and sizes of the wall layers. Composite layers made up of more than one material are defined as blocks of different widths and layer properties (see schematic drawing in Figure 1).

layer 1, block 1	
layer 2,block 1	layer 2, block 2

<table>
<tr><td>layer 3, block 1</td><td>layer 3, block 2</td><td>layer 3, block 3</td></tr>
<tr><td colspan="3">layer 4, block 1</td></tr>
</table>

Figure 1: Schematic drawing of WALFERFN modeling of wall sections

Figure 2 shows an input file for an R-13 wood-frame wall, with the middle layer separated into two blocks, one for the wood stud and the other for the cavity insulation. FERFG computes the response factors using a technique developed by Ceylan and Myers (Ceylan et al. 1979). WALFERFN loops through this computation twice to compute two sets of response factors, one with and one without the inside-film-resistance. DOE-2 uses the first to compute loads and the second to compute custom weighting factors.

```
r13wdfr  0 0 1
    6
    0.06690    0.2900      34.0000    1. wood
    0.09250    0.2600      50.0000    2. gypsum board
    0.02240    0.2000       1.1500    3. insulation
    0.41670    0.2200     116.0000    4. stucco
    0.04170    0.2800      30.0000    5. paper
   26.20000    0.1200     489.0000    6. steel
     3       8.000     # layers
     1       0.875     L-1
     4       8.000
     2       3.500     L-2
     3       7.187
     1       0.813
     1       0.500     L-3
     2       8.000
     0.68
```

Figure 2: WALFERFN input file for R-13 wood-frame wall

The rest of WALFERFN involves DOE-2 library generation operations, including reading an existing BDLLIB.BIN file, updating the pointers, rewriting the file contents, and writing the new response factor to the end of the file as required by DOE-2. For diagnostic purposes, WALFERFN also produces output files showing the gridding and the calculated response factor series. The contents of a DOE-2 response factor file can be printed by specifying "DIAGNOSTIC LIBRARY-CONTENTS" in the BDL input.

Test Two-dimensional Response Factor Simulations

A series of test simulations were done to illustrate the effect of two-dimensional heat flows through metal wall assemblies, and to verify that WALFERFN gave the same response factors as DOE-2 when the heat flows are one-dimensional; Table 1 lists the modeled wall sections.

Although response factors are a quick and efficient method to model dynamic heat flows, it is difficult to compare the computed response factor series to actual physical properties. In our work, we compared the equivalent U-values from the WALFERFN-generated response factors to those using simple steady-state hand calculations of wall properties. The equivalent U-values can be obtained from either DOEBDL or WALFERFN (see Figure 3).

Case	Wall Description	WALFERFN layer name	Comments	R-value*	U-value*
1	R-13 wood stud	r13wdfr	mostly parallel path one-dimensional heat flows	12.8	0.0778
2	R-13 steel stud w/ building paper	r13stla1	typical steel construction, moderate two-dimensional heat flows	7.6	0.1315
3	R-13 steel stud w/o building paper	r13stla2	similar to above	7.2	0.1387
4	R-13 steel rib w/ no web or flange	r13stlb	minimum two-dimensional heat flow effects	9.0	0.1105
5	R-13 continuous steel box frame	r13stlc	maximum two-dimensional heat flow effects	5.4	0.1847
6	R-13 all insulation	allins	no two-dimensional heat flow effects	14.5	0.0690

* includes exterior and interior air-film coefficients.

Table 1: Test Wall Sections

```
 CONSTRUCT MATRICES
 ENTER CEYLAN
 CALCULATE RESPONSE FACTORS 0allins   RESPONSE FACTORS WITH
INSIDE FILM RESISTANCE
 NRF =  6    CRATIO =  0.105784579    U =  0.069796969
   SUMS =  0.069797096  0.069796109  0.069802756
   1  1.932387273  0.022995385  0.513906372
   2 -1.860416735  0.039961178 -0.397896018
   3 -0.002064718  0.006114233 -0.041324782
   4 -0.000097440  0.000649352 -0.004371465
   5 -0.000010205  0.000068694 -0.000462434
   6 -0.000001079  0.000007267 -0.000048918
 CONSTRUCT MATRICES
 ENTER CEYLAN
 CALCULATE RESPONSE FACTORS 0allins   RESPONSE FACTORS
WITHOUT INSIDE FILM RESISTANCE
 NRF =  5    CRATIO =  0.001030573    U =  0.073269361
   SUMS =  0.073269361  0.073269361  0.073269361
   1  1.932717203  0.042188320  0.619516135
   2 -1.858202498  0.030891759 -0.546145823
   3 -0.001244107  0.000189042 -0.000100890
   4 -0.000001236  0.000000238 -0.000000061
   5 -0.000000001  0.000000000  0.000000000
```

Figure 3: Sample WALFERFN output file for layer "allins" (all insulation)

The last two columns of Table 1 give the equivalent R-values and U-values from WALFERFN for the six test cases. Since all six sections are nominally R-13, the reduced R-values for the steel cases, and particularly for Case 5, indicate significant amounts of two-dimensional heat flow. Case 6 is a hypothetical all-insulation case with no thermal bridging, for which the WALFERFN-calculated R-value corresponds closely to that from a steady-state hand calculation.

Determining the Width of Two-dimensional Heat Flow Effects

A practical problem with the use of two-dimensional response factors is that the stud ratio is embedded in the calculation and cannot be changed. Instead of generating differing response factors for different stud spacings, we decided to model a minimum width of the stud/cavity assembly exhibiting two-dimensional heat flow effects, beyond which the heat flows become one-dimensional and can be modeled separately as a standard one-dimensional DOE-2 wall layer. Walls of different stud spacings can then be modeled by changing the amounts of wall represented by the two- and one-dimensional response factors.

To determine this minimum width of two-dimensional heat flow, we modeled the worst case condition with a 16-gauge (0.080 inches) steel stud, and increased the width of the modeled section from 3.5 inches up to the full 16 inches. The heat flow through the one-dimensional section is represented by the all-insulation Case 6 described previously. We calculated the total R-value of the composite wall using the parallel path method, with the exact solution being that for the full 16 inch section.

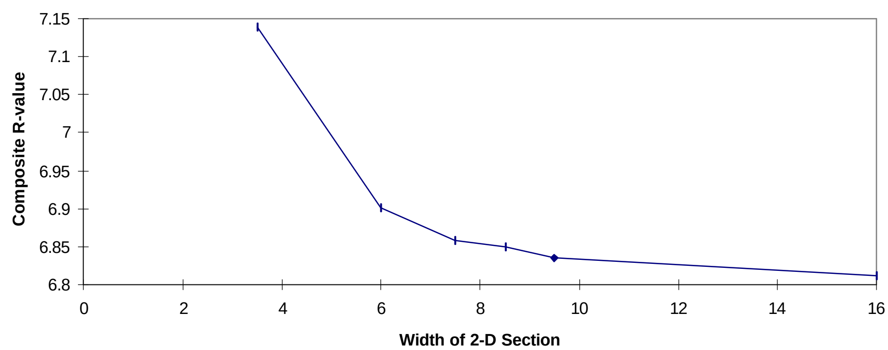

Figure 4: R-values of Wall Modeled Using One- and Two-Dimensional Sections

The results shown in Figure 4 indicate that the two-dimensional heat flow effects extend out surprisingly far from the steel studs, with significant errors using the parallel-path approximation unless the two-dimensional section is more than 9 inches wide. We decided to model the two-dimensional wall sections with a width of 10 inches. This means that a clear wall with a 16 inch stud spacing should be modeled with 59.4 percent as a two-dimensional wall section and 40.6 percent as a one-dimensional section, while a wall with a 48 inches stud spacing should have wall ratios of 20.8 to 79.2, respectively. Since Tuluca et al. (1996) have found that actual stud ratios in walls are often double that of the clear wall due to double studs at window frames, doorways, etc., it may be more accurate to use the two-dimensional response factors for the entire wall.

DOE-2 Two-dimensional Response Factor Library

Table 2 lists the 76 steel-frame wall sections modeled for the California Energy Commission using WALFERFN. The response factors are appended to the default BDLLIB.BIN file. The file was originally produced using a UNIX system, but was later ported to a prevalent PC DOE-2 format.

Layer name	Steel Gauge	Insul R-val	Stud depth	Int. Layer 1	Int. Layer 2	Ext. Layer 1	Ext. Layer 2	Ext. Layer 3	Ext. Layer 4	R-value
s16r11a0	16	R-11	3.5"	1/2" Gyp Bd	None	7/8" Stucco				4.95
s16r11c0	(0.060")	"	"	"	"	1/2" Plywd	1" Foam	1/2" Stucco		12.01
s16r11d0	"	"	"	"	"	1" Foam	1/2" Stucco			11.82
s16r11f0	"	"	"	"	"	1/2" Plywd				6.02
s18r11a0	18	"	"	"	"	7/8" Stucco				5.20
s18r11b0	(0.048")	"	"	"	"	1/2" Plywd	7/8" Stucco			6.50
s18r11c0	"	"	"	"	"	1/2" Plywd	1" Foam	1/2" Stucco		12.18
s18r11d0	"	"	"	"	"	1" Foam	1/2" Stucco			11.96
s18r11e0	"	"	"	"	"	1" Foam	1/2" Plywd			12.53
s18r11f0	"	"	"	"	"	1/2" Plywd				6.23
s18r13a0	"	R-13	"	"	"	7/8" Stucco				5.44
s18r13b0	"	"	"	"	"	1/2" Plywd	7/8" Stucco			6.84
s18r13c0	"	"	"	"	"	1/2" Plywd	1" Foam	1/2" Stucco		12.69
s18r13d0	"	"	"	"	"	1" Foam	1/2" Stucco			12.59
s18r13e0	"	"	"	"	"	1" Foam	1/2" Plywd			13.17
s18r13f0	"	"	"	"	"	1/2" Plywd				6.56
s18r15a0	"	R-15	"	"	"	7/8" Stucco				5.66
s18r15b0	"	"	"	"	"	1/2" Plywd	7/8" Stucco			7.16
s18r15c0	"	"	"	"	"	1/2" Plywd	1" Foam	1/2" Stucco		13.17
s18r15d0	"	"	"	"	"	1" Foam	1/2" Stucco			13.22
s18r15e0	"	"	"	"	"	1" Foam	1/2" Plywd			13.81
s18r15f0	"	"	"	"	"	1/2" Plywd				6.86
s24r11a0	24	R-11	"	"	"	7/8" Stucco				6.22
s24r11b0	(0.024")	"	"	"	"	1/2" Plywd	7/8" Stucco			7.37
s24r11c0	"	"	"	"	"	1/2" Plywd	1" Foam	1/2" Stucco		12.87
s24r11d0	"	"	"	"	"	1" Foam	1/2" Stucco			12.57
s24r11e0	"	"	"	"	"	1" Foam	1/2" Plywd			13.13
s24r11f0	"	"	"	"	"	1/2" Plywd				7.13
s24r13a0	"	R-13	"	"	"	7/8" Stucco				6.58
s24r13b0	"	"	"	"	"	1/2" Plywd	7/8" Stucco			7.82
s24r13c0	"	"	"	"	"	1/2" Plywd	1" Foam	1/2" Stucco		13.47
s24r13d0	"	"	"	"	"	1" Foam	1/2" Stucco			13.27
s24r13e0	"	"	"	"	"	1" Foam	1/2" Plywd			13.85
s24r13f0	"	"	"	"	"	1/2" Plywd				7.57
s24r15a0	"	R-15	"	"	"	7/8" Stucco				6.91
s24r15b0	"	"	"	"	"	1/2" Plywd	7/8" Stucco			8.25
s24r15c0	"	"	"	"	"	1/2" Plywd	1" Foam	1/2" Stucco		14.05
s24r15d0	"	"	"	"	"	1" Foam	1/2" Stucco			13.97
s24r15e0	"	"	"	"	"	1" Foam	1/2" Plywd			14.56
s24r15f0	"	"	"	"	"	1/2" Plywd				7.98
s18r11a1	18	R-11	3.5"*	1/2" Wd/ Insul	1/2" Gyp Bd	1/2" Wd/ Insul	1/2" Stucco			8.24
s18r11b1	(0.048")	"	"	"	"	"	1/2" Plywd	1/2" Stucco		9.22
s18r11c1	"	"	"	"	"	"	1/2" Plywd	1" Foam	1/2" Stucco	14.72
s18r11d1	"	"	"	"	"	"	1" Foam	1/2" Stucco		14.34
s18r11e1	"	"	"	"	"	"	1" Foam	1/2" Plywd		14.90
s18r11f1	"	"	"	"	"	"	1/2" Plywd			9.08
s18r13a1	"	R-13	"	"	"	"	1/2" Stucco			8.82
s18r13b1	"	"	"	"	"	"	1/2" Plywd	1/2" Stucco		9.88
s18r13c1	"	"	"	"	"	"	1/2" Plywd	1" Foam	1/2" Stucco	15.53
s18r13d1	"	"	"	"	"	"	1" Foam	1/2" Stucco		15.24
s18r13e1	"	"	"	"	"	"	1" Foam	1/2" Plywd		15.80
s18r15a1	18	R-15	3.5”	1/2" Gyp Bd	None	1/2" Insul	1/2" Stucco			9.37
s18r15b1	(0.048")	"	"	"	"	"	1/2" Plywd	1/2" Stucco		10.51
s18r15c1	"	"	"	"	"	"	1/2" Plywd	1" Foam	1/2" Stucco	16.31
s18r15d1	"	"	"	"	"	"	1" Foam	1/2" Stucco		16.12
s18r15e1	"	"	"	"	"	"	1" Foam	1/2" Plywd		16.70
s18r15f1	"	"	"	"	"	"	1/2" Plywd			10.36
s18r13f1	"	"	"	"	"	"	1/2" Plywd			9.74

Table 2: DOE-2 Two-Dimensional Response Factor Library

Layer name	Steel Gauge	Insul R-val	Stud depth	Int. Layer 1	Int. Layer 2	Ext. Layer 1	Ext. Layer 2	Ext. Layer 3	Ext. Layer 4	R-value
s18r19a0	18	R-19	6.0"	1/2" Gyp Bd	1/2" Wd/ Insul					6.39
s18r19b0	(0.048")	"	"	"	"	1/2" Stucco	7/8" Stucco			7.81
s18r19c0	"	"	"	"	"	1/2" Plywd	1" Foam	1/2" Stucco		13.69
s18r19d0	"	"	"	"	"	1" Foam	1/2" Stucco			13.55
s18r19e0	"	"	"	"	"	1" Foam	1/2" Plywd			14.13
s18r19f0	"	"	"	"	"	1/2" Plywd				7.52
s24r19a0	24	"	"	"	"	7/8" Stucco				8.16
s24r19b0	(0.024")	"	"	"	"	1/2" Plywd	7/8" Stucco			9.40
s24r19c0	"	"	"	"	"	1/2" Plywd	1" Foam	1/2" Stucco		15.04
s24r19d0	"	"	"	"	"	1" Foam	1/2" Stucco			14.79
s24r19e0	"	"	"	"	"	1" Foam	1/2" Plywd			15.36
s24r19f0	"	"	"	"	"	1/2" Plywd				9.14
s18r19a1	18	"	"*	1/2" Wd/ Insul	1/2" Gyp Bd	1/2" Wd/ Insul	1/2" Stucco			9.59
s18r19b1	(0.048")	"	"	"	"	"	1/2" Plywd	1/2" Stucco		10.65
s18r19c1	"	"	"	"	"	"	1/2" Plywd	1" Foam	1/2" Stucco	16.29
s18r19d1	"	"	"	"	"	"	1" Foam	1/2" Stucco		15.96
s18r19e1	"	"	"	"	"	"	1" Foam	1/2" Plywd		16.52
s18r19f1	"	"	"	"	"	"	1/2" Plywd			10.50

Table 2: DOE-2 Two-Dimensional Response Factor Library (continued)

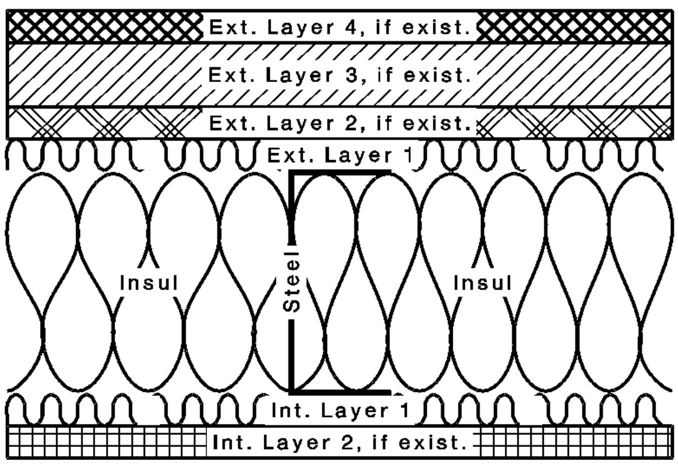

Figure 5: Schematic of wall assembly. This figure clarifies the columns in Table 2 labeled "Int. Layer 1", "Int. Layer 2", etc.

Downloading DOE-2 2-D Response Factor Library and Report

The 76 steel-frame wall DOE-2 2-D Response Factor Library may be downloaded from the California Energy Commission's FTP site at FTP://SNA.COM/pub/users/efftech/DOE2. The following files need to be downloaded: CECLIB.BIN, RF_LIST.TXT, and 76_WALLS.TXT. Replace the existing DOE-2 BDLLIB.BIN file with the CECLIB.BIN file. This new BDLLIB.BIN file is formatted for Jeff Hirsch's PC version of DOE-2. Contact Joe Huang for UNIX and other platforms. The 2-Dimensional Response Factor report may also be downloaded at the same FTP site when it becomes finalized. Read the README.2D file for instructions.

Acknowledgements

We would like to thank Jan Kosny of Oak Ridge National Laboratory for comparing WALFERFN response factors to the Oak Ridge response factor method.

References

1. Bull, J., Davis, P., Cumali, Z., Nozaki, S., Sullivan, R., Meixel, G., and Shen, L. 1981. "Earth Contact Subroutine Development", Task 7, DOE Contract No. DE- AC-03-80SF11508. Consultants Computation Bureau, Oakland CA.
2. Ceylan, T.H. and Myers, G.E. 1979. "Long-time Solutions to Heat-Conduction Transients with Time-Dependent Inputs.", *Journal of Heat Transfer*, 102, pp. 111-116.
3. Huang, Y.J., Ritschard, R., and Bull, J.C. 1987, “Technical Documentation for a Residential Energy Use Data Base Developed in Support of ASHRAE Special Project 53”, LBL-24306, Lawrence Berkeley Laboratory, Berkeley CA.
4. Tuluca, A., Lahiri, D., and Zaidi, J. 1996 “Calculation Methods and Insulation Techniques for Steel Stud Walls in Low-rise Multi-family Housing”, Winter 1996 *ASHRAE Transactions* (upcoming).

Help

For technical questions or comments on the article, please contact Joe Huang at Lawrence Berkeley National Laboratory. Phone (510) 486-7082, Fax (510) 486-4673, email YJHuang@lbl.gov.

For help on dowloading the library, contact James Trowbridge at the California Energy Commission, 1516-9th Street, MS: 42, Sacramento, CA 95814. Phone (916) 654-4044, Fax: (916) 654-4304

I B P S A

International Building Performance Simulation Association

Fifth International Conference Prague, Czech Republic

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Computer modeling and simulation is a most powerful approach for addressing the complex interactions encountered in buildings and the systems that service them. Modeling and simulation are evolving rapidly, and techniques not feasible just a few years ago are now becoming commonplace. The International Building Performance Simulation Association (IBPSA) was founded in 1986 to advance and promote the science of building performance simulation, with application to the design, construction, operation, and evaluation of new and existing buildings worldwide.

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Before 15 May 1997		**After 15 May 1997**	
ECE participants	USD 125	Late registration	USD 300
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The registration fee includes conference attendance, proceedings, lunches, morning and afternoon refreshments, early-bird reception, welcome reception, and banquet. The accompanying persons registration excludes conference attendance and proceedings.

VENUE

Prague (or Praha), the city of the hundred spires or the "Golden City" in the picturesque valley of the Vltava river, is the capital and center of industry, science, and culture of the Czech Republic. Prague is located in the centre of Europe and belongs among the best preserved historical cities with unique collections of architectural and cultural monuments. The Dean of the Faculty of Mechanical Engineering welcomes you to the Czech Technical University in Prague (CTU) which will host BS '97. CTU is situated just north of the centre of Prague, and is in easy reach from almost anywhere in Prague by the excellent metro system.

ACCOMMODATION

CTU co-owns a hotel (810 beds) which charges very competitive rates. Due to its popularity, Prague has accommodation available to suit every taste, from very economic to world-class.

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	I am interested in cultural tours
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Mail the advance registration form and address all inquiries to:

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Department of Environmental Engineering
Czech Technical University in Prague
Technicka 4
166 07 PRAGUE 6
Czech Republic

phone/fax +42 2 2345 5616
email bs97@fsid.cvut.cz
news: http://www.fsid.cvut.cz/bs97

UFO, er, URL Alert !

While these *urls* aren't directly related to building energy efficiency, they are useful (and fun!):

http://metro.jussieu.fr:10001/bin/cities/english	This subway navigator allows you to find routes in subway systems in various cities around the world.
http://maps.yahoo.com/yahoo/	Locate a detailed street map from almost any street address in the United States.

http://www.xe.net/currency/	Universal currency converter

DOE-2 DIRECTORY

Program Related Software and Services

Contact the vendors for prices and ordering information

Mainframe and Workstation Versions of DOE-2

DOE-2.1D and 2.1E (Source code, executable code and documentation) For 2.1E DEC-VAX, Order #000158-DOVAX-02 For 2.1E SUN-4, Order #000158-SUN-0000 For 2.1D DEC-VAX, Order #000158-D6220-01 For a complete listing of the software available from ESTSC order their "Software Listing" catalog ESTSC-2. [See *User News* Vol. 16, No. 3, p. 21]	Energy Science / Technology- Software Center (ESTSC) P.O. Box 1020 Oak Ridge, TN 37831-1020 Phone: (615) 576-2606 Fax: (615) 576-2865 email:ESTSC@ADONIS.OSTI.GOV http://www.doe.gov/html/osti/estsc/estsc.html
FTI-DOEv2.1E (Source code and documentation) Combined source code package for both VAX and SUN versions of DOE-2.1E. Available on most distribution formats and for most operating systems (1/4" QIC tape, TK50 tape, 3.5" floppy, etc). Note: this is the distribution package only, no executables. Complete documentation for DOE-2.1E, digitally reproduced, spiral bound, and separated into multi-volume sets. [See *User News* Vol. 12, No. 4, p. 16]	Finite Technologies, Inc 3763 Image Drive Anchorage, AK 99504 Contact: Scott Henderson Phone: (907) 333-8933 Fax: (907) 333-4482 email: info@finite-tech.com http://www.finite- tech.com/fti/home.htmld

PC Versions of DOE-2

ADM-DOE2 ADM-DOE2 (DOE-2.1E) is compiled for use on 386/486 PCs with a math co-processor and 4MB of RAM. It runs in a DOS or Windows environment and is a highly reliable and tested version of DOE-2 which contains all of the 1994/95 enhancements to the program. The package contains everything needed to run the program: program files, utilities, sample input files, and weather files. More than 300 weather files are available (TMY, TRY, WYEC, CTZ formats) for the U.S. and Canada. [See*User News* Vol. 7, No. 2, p. 6]	ADM Associates, Inc. 3239 Ramos Circle Sacramento, CA 95827 Contact: Marla Sullivan, Sales Phone: (916) 363-8383 Fax: (916) 363-1788
CECDOEDC (Version 1.0A) A microcomputer version of DOE-2.1D with a pre- and post-processor designed strictly for compliance use within the State of California. It generates some of the standard compliance forms as output. Order P40091009 for the CECDOEDC Program with Manuals. Order P40091010 for the DOE-2.1 California Compliance Manual. [See *User News* Vol. 12, No. 4, p. 13]	MS: 13 -- Publication Office California Energy Commission P.O. Box 944295 Sacramento, CA 94244-2950 Phone: (916) 654-5106 http://agency.resource.ca.gov/cectext/ ETEC.html
DOE-24/Comply-24 DOE-24 is a special DOE-2 release which is both a California-approved compliance program for the state's non-residential energy standards, and a stand-alone version of DOE-2.1E that includes a powerful yet easy-to-use input preprocessor. A demonstration program is available upon request. [See *User News* Vol. 12, No. 2, p. 2]	Gabel-Dodd Associates 1818 Harmon Street Berkeley, CA 94703-2416 Contact: Rosemary Howley Phone: (510) 428-0803 Fax: (510) 428-0324

Caveat : We list third-party DOE-2-related products and services for the convenience of program users, with the understanding that the Simulation Research Group does not have the resources to check the DOE-2 program adaptations and utilities for accuracy or reliability.

PC Versions of DOE-2 (continued)

DOE-Plus DOE-Plus, a complete implementation of DOE-2.1D, is used to interactively input a building description, run DOE-2, and plot graphs of simulation results. Features include interactive error checking, context-sensitive help for all DOE-2 keywords, a 3-D view of the building that can be rotated, and several useful utilities. Also from ITEM Systems: **Demand Analyzer,** uses templates of building types and vintages to simplify DOE-2 input requirements. Online help feature. **Prep,** a batch preprocessor, ideal for parametric studies, that enables conditional text substitution, expression evaluation, and spawning of other programs. [See *User News* Vol. 11, No. 4, p. 4 and Vol. 13, No. 2, p. 54, and Vol. 16, No. 1, p. 28-32	ITEM Systems 1402 - 3rd Avenue, #901 Seattle, WA 98101 Contact: Steve Byrne Phone: (206) 382-1440 Fax: (206) 382-1450 email: byrne@item.com
EZDOE EZDOE is an easy-to-use PC version of DOE-2.1D. It provides full screen, fill in the blank data entry, dynamic error checking, context-sensitive help, mouse support, graphic reports, a 750-page user manual, extensive weather data, and comprehensive customer support. EZDOE integrates the full calculation modules of DOE-2 into a powerful, full implementation of DOE-2 on DOS-based 386 and higher computers. [See *User News* Vol. 14, No. 2, p. 10 and No. 4, p. 8-14]	Elite Software, Inc. P.O. Drawer 1194 Bryan, TX 77806 Contact: Bill Smith Phone: (409) 846-2340 Fax: (409) 846-4367 email: 76070.621@compuserve.com
FTI-DOEv2.1E Highly optimized version of DOE-2.1E software, available for most computing systems. Current support: MSDOS and Windows 3.x, Windows NT, OS/2, RS/6000 (AIX), NeXT, SUN, UNIX (most systems). Call for platforms not listed. Documentation and weather files are available. Also FTI-DOEv2.1E source code, highly optimized and portable version; will compile for most systems. [See *User News* Vol. 12, No. 4, p. 16]	Finite Technologies, Inc 821 N Street, #102 Anchorage, AK 99501 Contact: Scott Henderson Phone: (907) 272-2714 Fax: (907) 274-5379 email: info@finite-tech.com http://www.finite-tech.com/fti/home.htmld
MICRO-DOE2 MICRO-DOE2 (2.1E), running in a DOS or Windows environment, is a widely used, reliable, and tested PC version of DOE-2. It includes automatic weather processing, batch file creation, and a User's Guide with instructions on how to set up a RAM drive. System requirements: 386/486 PC with 4 MB of RAM and math co-processor. Also from ACROSOFT/CAER Engineers: **NETPath**, a network edition of MICRO-DOE2 for up to five users, allows you to store and run DOE-2 application files on one machine using input files from another machine. The result is improved space usage and project file management. **POWERPath**, for single machines, allows you to keep MICRO-DOE2 application files in one directory and submit input from any other directory. **BDL Builder** is a user-friendly Windows-implemented pre-processor for DOE-2.1E that allows the description of specific building and HVAC characteristics with numeric input by preparing databases, or building blocks, and then selecting records from the databases to assemble a complete input. **E2BB** translates existing DOE-2.1E text input to BDLBuilder. Most weather files, TRY, TMY, CTZ, WYEC plus many European files. [See *User News* Vol. 7, No. 4, p. 2; Vol. 11, No. 1, p. 2; Vol. 15, No. 1, p. 8; Vol. 15, No. 3, p. 4; Vol. 16, No. 2, p. 1,7; Vol. 16, No. 4, p. 7-8]	ACROSOFT / CAER Engineers 814 Eleventh Street Denver, CO 80401 Contact: Don Croy Phone: (303) 279-8136 Fax: (303) 279-0506 email: 102447.2611@COMPUSERVE.COM

PC Versions of DOE-2 (continued)

PRC-DOE2 A fast, robust and up-to-date PC version of DOE-2.1E. Runs in extended memory, is compatible with any VCPI compliant memory manager and includes its own disk caching. 377 weather data files available (TMY, TRY, WYEC, CTZ) for the U.S. and Canada **PRC-TOOLS** , a set of PC programs that aids in extracting, analyzing and formatting hourly DOE-2 output. Determines energy use, demand, and cost for any number of end-uses and periods. Automatically creates 36-day load shapes. Custom programs also available.	Partnership for ResourceConservation 140 South 34th Street Boulder, CO 80303 Contact: Paul Reeves Phone: (303) 499-8611 FAX: (303) 554-1370 email: paulreeves@aol.com
VisualDOE-2.0 for Windows ™ VisualDOE-2.0, which uses DOE-2.1E as the calculation engine, enables architects and engineers to quickly evaluate the energy savings of HVAC and other building design options. Program is supported by context-sensitive on-line help. Program includes climate data for the 16 California weather zones. A demo can be downloaded from their website. [See *User News* Vol. 15, No. 2, p. 10; Vol. 16, No. 4, p. 9-16]	Eley & Associates 142 Minna Street San Francisco, CA 94105 Charles Eley or John Kennedy Phone: (415) 957-1977 / Fax: -1381 email: celey@eley.com http://www.eley.com

Pre- and Post-Processors for DOE-2

DrawBDL DrawBDL, Version 2.02, is a graphic debugging and drawing tool for DOE-2 building geometry; it runs on PCs under Microsoft Windows. DrawBDL reads your BDL input and makes a rotatable 3D drawing of your building with walls, windows, and building shades shown in different colors for easy identification. [See *User News*, Vol. 14, No. 1, p. 5-7, Vol. 14, No. 4, p. 16-17, and Vol. 16, No. 1, p.37]	Joe Huang & Associates 6720 Potrero Avenue El Cerrito, CA 91364 Contact: Joe Huang Phone/Fax:: (510) 236-9238
Visualize-IT Visual Data Analysis Tools The ***Energy Information Tool*** is a Microsoft Windows 3.1 program for looking at and understanding metered or DOE-2.1E hourly input data. It provides the unprecedented ability to see all 8760 (or 35040) data points for a year's worth of data. You get an overview of the data with an EnergyPrint™ and can then explore the data with a variety of tools including load shapes, load duraction curves, etc. This program requires a 486 computer and SVGA grapics capabilities. The ***Calibration Tool*** is a Microsoft Windows 3.1 program for comparing DOE-2.1E hourly output data to total load and/or end-use metered data. Options include monthly demand and load 2D graphs, maximum and seasonal load shapes, average load profiles, end use residuals, monthly average week and weekend days, and dynamic comparison load shapes. This program requires a 486 computer and SVGA grapics capabilities. [See *User News* Vol. 17, No. 2, p. 2-6]	RLW Analytics, Inc. 1055 Broadway, Suite G Sonoma, CA 95476 Contact: Jim McCray Pat Bailey Jedd L. Parker Phone: (707) 939-8823 Fax: (707) 939-9218 email: info@rlw.com www: http://www.rlw.com
D O E 1 2 3 Uses Lotus 1-2-3 to graphically display DOE-2.1D output as barcharts, pie charts, and line graphs. [See *User News* Vol. 10, No. 3, p. 5]	Ernie Jessup 4977 Canoga Avenue Woodland Hills, CA 91364 Phone: (818) 884-3997
Graphs for DOE-2 2-D, 3-D, hourly, daily, and psychrometric plots [See *User News* Vol. 13, No. 1, p. 5]	Energy Systems Laboratory Texas A&M University College Station, TX 77843 Contact: Jeff Haberl Phone : (409) 845-6065 Fax: (409) 862-2762
Pre-DOE A math pre-processor for BDL.	Nick Luick 19030 State Street Corona, CA 91719 Phone: (714) 278-3131

TOOLS AND TRAINING

***User News* (a quarterly newsletter)** Sent without charge, the newsletter prints documentation updates and changes, bug fixes, inside tips on using the programs more effectively, and articles of special interest to users. Regular features include a directory of program-related software and services and an order form for documentation. The winter issue features an index of articles printed in all the back issues. Also available electronically at http://eande.lbl.gov/BTP/SRG/UNEWS	Simulation Research Group Bldg. 90, Room 3147 Lawrence Berkeley National Laboratory Berkeley, CA 94720 Contact: Kathy Ellington Fax: (510) 486-4089 email: kathy@gundog.lbl.gov
Help Desk Bruce Birdsall Call or fax Bruce Birdsall if you have a question about using DOE-2. If you need to fax an example of your problem to Bruce, please be sure to telephone him prior to sending the fax. This is a free service provided by the Simulation Research Group at Lawrence Berkeley National Laboratory.	Bruce Birdsall Phone/Fax: (510) 829-8459 Monday through Friday 10 a.m. to 3 p.m. Pacific Time
Training DOE-2 courses for beginning and advanced users.	Energy Simulation Specialists 64 E. Broadway, Suite 230 Tempe, AZ 85282 Contact: Marlin Addison Phone: (602) 967-5278
DOE-2 training for small groups and individuals.	Gary H. Michaels, P.E. 1512 Crain Street Evanston, IL 60202 Phone: (708) 869-5859 email: g_michaels@msn.com
Instructional DOE-2 Video and Manual Takes you step-by-step in DOE-2.1D input preparation and output interpretation.	Contact: Dr. Moncef Krarti, Acting Director JCEM/U. Colorado CEAE Dept CB 428 Boulder, CO 80309-0428 Phone: (303) 492-3389 or 7317

DOE-2.1E Bug Fixes via FTP

If you have Internet access you can obtain the latest bug fixes to DOE-2.1E by anonymous ftp. Here's how...

ftp to either gundog@lbl.gov or to 128.3.254.10
login: *type* anonymous
passwd: *type in your email address*

After logging on, go to directory pub/21e-mods ; bug fixes are in files that end with **.mod** . A description of the fixes is in file **VERSIONS.txt** in directory **pub** . Each fix has its own version number, ***nnn*** , which is printed out as DOE-2.1E- *nnn* on the DOE-2.1E banner page and output reports when the program is recompiled with the fix. You may direct questions about accessing or incorporating the bug fixes to Ender Erdem (ender@gundog.lbl.gov).

WEATHER RESOURCES

TMY2 weather data for DOE-2. ENERGOS will provide TMY2 data for 239 cities converted for use with DOE-2 for PC versions of the program (DOE-2.1C through DOE-2.1E).	Kurmit Rockwell ENERGOS 1705-14th Street, #401 Boulder, CO; 80302 Phone: (303) 499-7907 / Fax: (303) 449-7605
Comprehensive collection of **TRY**, **TMY** and **CTZ** weather file libraries, from NCDC, which can be used on all PC versions of DOE-2. Includes original source data and pre-formatted packed versions on a single IBM format CD. For Canadian users, the CD contains five weather files representing the five climate regions established by the Canadian energy codes. Individual sites available.	Jenny Lathum or Martyn Dodd EnergySoft 100 Galli Drive, Suite 1 Novato, CA 94949 Phone: (800) 467-4738 Fax: (415) 883-5970
European Weather Files	Andre Dewint Alpha Pi, s.a. rue de Livourne 103/12 B-1050 BRUXELLES, Belgium Phone: 32-2-649-8359 / Fax: 32-2-649-9437
TMY data sets - download from the world wide web **TMY2** data sets - download from the world wide web	TMY: http//oipea-www.rutgers.edu/html_docs/TMY/tmy.html TMY2: http://rredc.nrel.gov/solar/data/nsrdb/tmy2
TMY (Typical Meteorological Year) **TRY** (Test Reference Year)	National Climatic Data Center 151 Patton Avenue, #120 Asheville, NC 28801 Phone: (704) 271-4871 order / Fax 271-4876
CTZ (California Thermal Climate Zones)	California Energy Commission Bruce Maeda, MS-25 1516-9th Street Sacramento, CA 95814-5512 1-800-772-3300 Energy Hotline
WYEC (Weather Year for Energy Calculation)	ASHRAE 1791 Tullie Circle N.E. Atlanta, GA 30329 Phone: (404)636-8400 / Fax: (404)321-5478
Canadian Weather Files in **WYEC2** Format [Note: the original long-term data sets, up to 40 years of data, from which the CWEC files were derived can also be obtained directly from Environment Canada. contact Mr. Robert Morris at (416) 739-4361.]	Dr. Didier Thevenard Watsun Simulation Lab University of Waterloo Waterloo, Ont., N2L-3G1 Canada Phone: (519) 888-4904 / Fax: (519) 888-6197 watsun@helix.watstar.uwaterloo.ca

DOE-2 ENERGY CONSULTANTS

Consulting Engineers Charles Fountain Burns & McDonnell Engineers 8055 E. Tufts Avenue, #330 Denver, CO 80237 (303) 721-9292	**Consultant** Greg Cunningham Cunningham + Associates 512 Second Street San Francisco, CA 94107 (415) 495-2220
Consultant Philip Wemhoff 1512 South McDuff Avenue Jacksonville, FL 32205 (904) 632-7393	**Consultant** Jeff Hirsch 12185 Presilla Road Camarillo, CA 93012 (805) 532-1045
Consultants Charles Eley, John Kennedy Eley Associates 142 Minna Street San Francisco, CA 94105 (415) 957-1977	**Computer-Aided Mechanical Engineering** Mike Roberts Roberts Engineering Co. 11946 Pennsylvania Kansas City, MO 64145 (816) 942-8121
Consultant Steven D. Gates, P.E. Building HVAC Design/Performance Modeling 11608 Sandy Bar Court Gold River, CA 95670 (916) 638-7540	**Consultant** Donald E. Croy ACROSOFT/CAER Engineers, Inc. 814 Eleventh Street Golden, CO 80401 (303) 279-8136
Mechanical Engineer Chuck Sherman Energy Simulation Specialists 64 East Broadway, #230 Tempe, AZ 95282 (602) 967-5278	**Energy Engineering: Commercial & Institutional** Michael W. Harrison, P.E. 139 Bluebird lane Whitehall, Montana 59759 (406) 287-5370
Consultant Shiva Subramanya Criterion, Inc. 5331 SW Macadam Ave., Suite 205 Portland, OR 97201 (503) 224-8606	**Hourly Calibrated DOE-2 Analysis** Jeff S. Haberl Energy Systems Laboratory Texas A&M University College Stn., TX 77843-3123 (409) 845-6065
Consultant/Building Systems Analysis Robert H. Henninger, P.E. GARD Analytics, Inc. 1028 Busse Highway Park Ridge, IL 60068-1802 (847) 698-5686	**Energy Management Specialist** Hank Jackson, P.E. P.O. Box 675 Weaverville, NC 28787-0675 (704) 658-0298
Consultant Martyn C. Dodd Gabel Dodd Associates 100 Galli Drive, # 1 Novato, CA 94949 (415) 883-5900	**Consulting Engineer** Prem N. Mehrotra General Energy Corporation 230 Madison Street Oak Park, IL 60302 (708) 386-6000
Architectural Engineering Michael P. Doerr Skidmore, Owings & Merrill LLP 224 South Michigan Avenue, Suite 1000 Chicago, Illinois 60604 (312) 360-4623 michael.p.doerr@som.com	**Consulting Engineers/Computer Simulation Sciences** Robert E. Gibeault A-TEC 5515 River Avenue, Suite 301 Newport Beach, CA 92663 (714) 548-6836
Consulting Engineer Susan Reilly Enermodal Engineering 1554 Emerson Street Denver, CO 80218 (303) 861-2070	**Technical Real World Analysis** David J. Schwed Romero Management Associates 1805 West Avenue K, # Lancaster, CA 93534 (805) 940-0540
Energy Simulation Consultant Joel Neymark, P.E. 2140 Ellis Street Golden, CO 80401 (303) 384-3672	**Consulting Engineer** Gregory Banken, P.E. Q-Metrics, Inc. P.O. Box 3016

	Woodinville, WA 98072 (205) 915-8590

DOE-2 ENERGY CONSULTANTS (continued)

Consulting Engineer Chandra Shinde, P.E. ENVIRODESIGN GROUP 385 S. Lemon Ave., E-266 Walnut, CA 91789 (909) 598-1980	**Energy Engineering and Analysis** Leo Rainer Davis Energy Group, Inc. 123 C Street Davis, CA 95616 (916) 753-1100
Energy Codes DSM Doug Mahone The Heshong Mahone Group 4610 Paula Way Fair Oaks, CA 95628 (916) 962-7001	**Consulting Engineer** Gary H. Michaels, P.E. 1512 Crain Street Evanston, IL 60202 (708) 869-5859
Consulting Engineer Robert Mowris, P.E. 606 Pelton Avenue Santa Cruz, CA 95060 (408) 454-0606	**Energy/DSM-Consultants** Adrian Tuluca Steven Winter Associates 50 Washington Street Norwalk, CT 06854 (203) 852-0110
Modeling Specialist Norm Weaver Interweaver Consulting P.O. Box 775444 Steamboat Springs, CO 80477 (970) 870-1710	**Consultant/Building Systems Engineering** Ellen Franconi P.O. Box 1284 Boulder, CO 80306 (303) 786-7319
Large Facility Modeling George Marton Consulting Engineer 1129 Keith Avenue Berkeley, CA 94708 (510) 841-8083	**Consultant/Engineer** David A. Cohen Architectural Energy Corporation 2540 Frontier Avenue, #201 Boulder, CO 80301 (303) 444-4149
Consultant Kurmit Rockwell Rocky Mountain Energy Services 1705 14th Street, Suite 401 Boulder, CO 80302 (303)499-7907	**Design Assistance/Model Review** James Fireovid, P.E. and Khaled Yousef SAIC Energy Solutions Division 1 Marcus Boulevard Albany, NY 12205 (518) 458-2249
Consultant Steve Byrne ITEM Systems 1402 - 3rd Avenue, #901 Seattle, WA 98101 (206) 382-1440	**Research, Education, and Consulting** Dr. Brian A. Rock, P.E. Arch/Engrg Dept Marvin Hall University of Kansas Lawrence, KS 66045-2222 (913) 864-3434

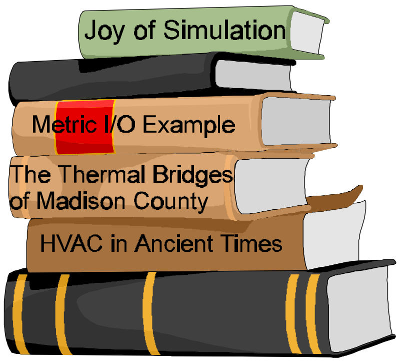
Stats from LBNL's Center for Building Science:

The Laboratory's DOE-2 model has been used extensively by the California Energy Commission (CEC) for development of building standards and other purposes. The CEC estimates that the annual energy cost savings from the Title 24 non-residential buildings standard, which was designed with the help of DOE-2, was $420 million in 1985, $970 million in 1992, and will increase to $1.6 billion in 1999. The cumulative savings in California alone are estimated to be $4.9 billion (1985-1992), and $13.8 billion (1985-1999).

I N T E R N A T I O N A L DOE-2 E N E R G Y C O N S U L T A N T S

DOE-2 Simulation Specialist René Meldem Meldem Energie SA Ch. de l'Ancienne Pointe 1 CH-1920 Martigny Switzerland	**Energy Consultant** Philip Schluchter Institut fur Bauphysik Klein Urs Graf-Strasse 1 CH4052 Basel Switzerland
Consultant, Distributor for FTI-DOEv2.1E Andre Dewint rue de Livourne 103/12 B-1050 BRUXELLES Belgium	**Energy Consultant** Gerhard Zweifel Zentralschweizerisches Technikum Luzern (ZTL) Abt. HLK CH-6048 Horw Switzerland
Consultant Curt Hepting, P.Eng. EnerSys Analytics 3990 Lynn Valley Road North Vancouver, B.C. V7K 2S9 Canada	**Energy Research and Consulting** Joerg Tscherry Building Equipment Section 175 EMPA 8600 Dubendorf Switzerland
Energy and Environmental Engineering Neil A. Caldwell D. W. Thomson Consultants, Ltd. 1985 West Broadway Vancouver, BC V6J 4Y3 Canada	

DOE-2.1E Documentation Update



Sample Run Book:
Metric Input/Output Example

Recently, it was brought to our attention that Section 13 of the DOE-2.1E Sample Run Book was missing. Sure enough, due to an error on our part Section 13, the Metric I/O Example, was never sent to the printer. If you would like a copy of this example, please fax your request to Kathy Ellington at (510) 486-4089.
You may also email KLEllington@lbl.gov

DOE-2 RESOURCE CENTERS

The people listed here have agreed to be primary contacts for DOE-2 program users in their respective countries. Each resource center has the latest program documentation, all back issues of the User News, and recent LBNL reports pertaining to DOE-2. These resource centers will receive copies of all new reports and documentation. Program users can then make arrangements to get photocopies of the new material for a nominal cost. We hope to establish resource centers in other countries; please contact us if you are interested in establishing a center in your area.

South America Prof. Roberto Lamberts Universidade Federal de Santa Catarina Campus Universitario--Trindade Cx. Postal 476 88049 Florianopolis SC BRASIL Telephone: (55)482-31-9272 Fax: (55)48-231-9770 email: Lamberts@ecv.ufsc.BR	**Australasia** Dr. Deo K. Prasad/P. C. Thomas SOLARCH University of New South Wales P.O. Box 1 Kensington, N.S.W. 2033 AUSTRALIA Telephone: (61)-2-697-5783 (P.C. Thomas) Fax: (61) 2-662-4265 or -1378 email: PC.Thomas@unsw.EDU.AU
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Hong Kong, China, Taiwan, Japan and Korea Dr. Sam Chun-Man HUI or K.P. Cheung Department of Architecture University of Hong Kong Pokfulam Road HONG KONG http://arch.hku.hk/research/BEER/doe2/doe2.htm Telephone: (852) 2859-2133 (direct to Sam Hui) Fax: (852) 2559-6484 email: CMHUI@HKUCC.HKU.HK	**Switzerland** René Meldem Meldem Energie SA Ch. de l'Ancienne Pointe 1 CH-1920 Martigny SWITZERLAND Telephone: (41) 26 22 96 96 Fax: (41) 26 22 96 97 email: 106034.630@compuserve.com

World-Wide Web and Internet Sites for Building Energy Efficiency

http://www.bso.uiuc.edu	**BLAST** Support Office
(net) sci.engr.heat-vent-ac	**HVAC** discussion group.
(net) sci.engr.lighting	**Lighting** discussion group.
http://energy.ca.gov/energy/ cectext/ETEC.html	**California Energy Commission's Energy Technology and Education Center**. See *User News* , Vol. 16, No. 1, p. 42.
http://www.hike.te.chiba-u.ac.jp/ ikeda/CIE/publ/110-94.html	**The International Commission on Illumination - CIE** See *User News* , Vol. 16, No. 1, p. 44.
http://www.eren.doe.gov/	**EREN**: Energy Efficiency and Renewable Energy Network of the U.S. Department of Energy . See *User News* , Vol. 16, No. 1, p. 44.
http://www.doe.gov/	**U.S. Department of Energy** . See *User News* , Vol. 15, No. 4, p. 1.
http://www.whitehouse.gov/	**The White House** home page contains an Interactive Citizens Handbook that lists U.S. Government servers by agency. Use this site as a jumping-off point to explore other Federal agencies. See *User News* , Vol. 15, No. 4, p. 1.
http://www.fedworld.gov/	**FedWorld** is the U.S. Government's Federal Information Network home page. It lists web servers, ftp, gopher, and telnet sites and is organized by subject categories.
http://www.fedworld.gov/ntis/ ntishome.html	**National Technical Information Service** NTIS gathers and markets scientific, technical and business-related information.
http://www.caddet-ee.org	**Center for the Analysis and Dissemination of Demonstrated Energy Technologies** An IEA program for collecting and disseminating information on, energy-efficient and renewable energy technologies. See *User News* , Vol. 16, No. 2, p. 23.
http://crest.org/aceee	**American Council for an Energy-Efficient Economy** A non-profit organization for the advancement of energy efficiency. See *User News* , Vol. 16, No. 2, p. 23.
http://www.ashrae.org	**American Society of Heating, Refrigeration and Air-Conditioning** An international membership organization for HVAC professionals.*User News* , Vol. 16, No. 3, p. 31.
http://www.cisti.nrc.ca/irc/ irccontents.html	**[Canadian] Institute for Research in Construction** IRC is part of the NRC, Canada's premier science and technology agency. See *User News* , Vol. 16, No. 3, p. 31.
http://next1.mae.okstate.edu/ ibpsa/	**International Building Performance Simulation Association** A not-for-profit international society of building performance simulation professionals.
http://www.fsec.ucf.edu/	**Florida Solar Energy Center** FSEC is the State of Florida's energy institute specializing in energy research and education in partnership with private and public organizations.
http://beijing.dis.anl.gov/ee-cgi-bin/hem.pl	**Home Energy Magazine** An impartial source of analysis to aid the energy practitioner and the public in making informed decisions on energy conservation measures.
http://eande.lbl.gov/BTP/WDG/ **RESFEN/resfen.html** **SUPERLITE/superlite2.html** **WDG.html**	**Download Free Fenestration software from LBNL** See *User News*, Vol. 17, No. 1, p. 14. **RESFEN-2.4** - calculates residential fenestration heating and cooling enegy use and costs **SUPERLITE-2.0** - calculates daylight illuminance distributions for room geometries **WINDOW-4.1** - thermal analysis program to characterize window product performance
http://www.energy.ca.gov/report s /title24/index.html	**State of California's Title 24 Building Energy Standards**
http://fcn.state.fl.us/fdi/fdi-home.htm	**State of Florida's Design Initiative (FDI)**
http://fcn.state.fl.us/fdi/e-design/online/edo.htm	***e-design,*** the online newsletter for Florida's Design Initiative
http://www.energy.wsu.edu/ **ep/eic** **ep/eic/eicsoft.htm** **ep/eic/eicfiles.htm**	The **Energy Program (EP)** of Washington State University. **Energy Ideas Clearinghouse**, 925 Plum St S.E., Olympia, WA 98504-3171 (360) 956-2237 Software and files from the Energy Ideas Clearinhouse More download-able energy software from the Energy Ideas Clearinhouse
http://eande.lbl.gov/CBS/VH/	The **Virtual Home Energy Advisor** from LBNL's Center for Building science. Run a

advisor.html quick heating-cooling model and see how much homes in your region can save.

* * * Featured Sites This Issue * * *

World-Wide Web Sites for Building Energy Efficiency

ENERGY PROGRAM
Washington State University
http://www.energy.wsu.edu

The Washington State University Cooperative Extension's Energy Program (EP) was established July 1st, 1996, to provide energy programs and services within the transportation, residential, commercial, and industrial sectors. Many of the current programs were transferred to WSU from the former Washington State Energy Office (WSEO).

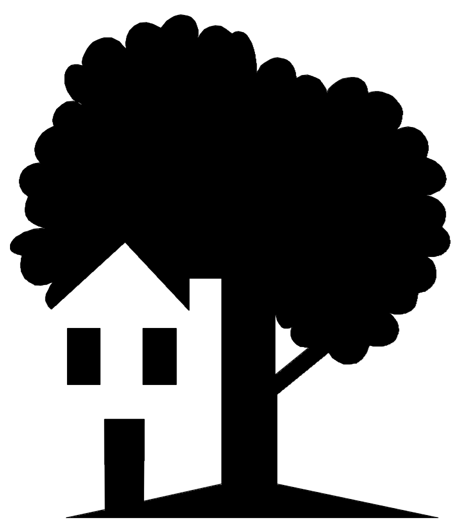
http://www.energy.wsu.edu/ep/eic
Energy Ideas Clearinghouse (EIC)
925 Plum Street S.E.
Olympia, WA 98504-3171
Phone: (360) 956-2237
The EIC provides information and technical support for increasing energy efficiency in the commercial and industrial sectors. Up-to-date information on products and technologies; national, state, and local programs; and the environmental aspects of energy use is available. The EIC offers a technical assistance hotline and an electronic bulletin board to provide comprehensive and timely answers to technical questions posed by utilities and building professionals. Also, down-loadable software and files are available at

http://www.energy.wsu.edu/ep/eic/eicsoft.htm
and
http://www.energy.wsu.edu/ep/eic/eicfiles.htm

HOME ENERGY SAVER
From the Center for Building Science at Lawrence Berkeley National Laboratory

http://eande.lbl.gov/CBS
Lawrence Berkeley National Laboratory's Center for Building Science is an international leader in developing and commercializing energy-efficient technologies and analytical techniques and in documenting ways of improving the energy efficiency and indoor environmental quality of residential and commercial buildings.

http://eande.lbl.gov/CBS/VH/advisor.html
The Virtual Home Advisor is the first internet-based tool for calculating energy use in residential buildings. The project is currently supported by the U.S. Environmental Protection Agency as part of its national ENERGY STAR Programs for improving energy efficiency in homes.



"Building Loads Analysis and System Thermodynamics"

blastnews

The **Building Loads Analysis and System Thermo-dynamics** (**BLAST**) program is a comprehensive energy analysis tool that allows users from a wide range of experience levels to calculate building heating and cooling loads as well as simulate primary and secondary equipment. The current PC version of BLAST includes several pre- and post-processing auxiliary programs to create BLAST input files and reduce program output data. Documentation in a Windows™ Help format is included in the standard BLAST package; printed documentation is also available. Source code may be obtained from the BLAST Support Office (BSO), allowing BLAST to be ported to other computing environments. The BSO also distributes the WinLCCID96 life cycle cost program [See *User News* Vol. 16, No. 4, p. 5]. Please consult the BSO web page or catalog for the latest information on prices, system requirements and available weather sites.

BLAST Support Office (BSO)

30 Mechanical Engineering Bldg

University of Illinois

1206 West Green Street

Urbana, IL 61801

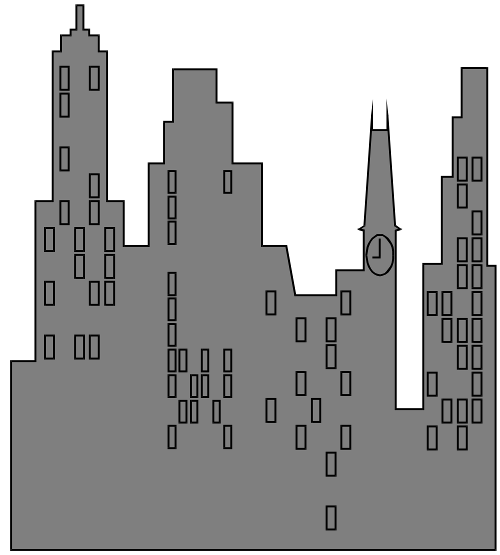
Telephone: (217) 333-3977

FAX: (217) 244-6534

email: support@blast.bso.uiuc.edu

http://www.bso.uiuc.edu

The **Heat Balance Load Calculator** (**HBLC**) interface provides a graphical, Windows™-based environment for obtaining BLAST input files and analyzing simulation results. Within HBLC, each story of the building is represented as a floor plan which may contain several separate zones. Numerous other building details may be investigated and accessed through simple mouse operations. On-line helps provide valuable on-the-spot assistance that will benefit both new and experienced BLAST users. HBLC makes the process of developing input files more intuitive and efficient; it is available as part of the standard BLAST package. A free demo may be downloaded from the BSO web page or obtained by contacting the BSO.



EnergyBase: The "Best Of" DOE–2 and BLAST

As has been mentioned in previous editions of the *User News*, researchers at the Lawrence Berkeley National Laboratory, the University of Illinois at Urbana-Champaign, and the US Army Construction Engineering Research Laboratory are collaborating on a project to combine the best features of the DOE–2 and BLAST programs into a single, more powerful engineering tool. The program resulting from this effort is now being called "EnergyBase" since it will be the basis for a next generation building simulation program. An overview of EnergyBase is shown in Figure 1.

Modularization and integration will be two key features of the new EnergyBase program. Modularization of DOE–2 and BLAST "legacy" code will allow the research team and other developers to more easily interface with the new program. Adding custom models for an innovative air handling system, an improved chiller model, or any other building process will no longer require intimate knowledge of the program code. Instead, other modules will "plug into" EnergyBase through a single calling statement rather than working within the existing programming structure which can require extensive modifications. This will also allow the development team to more efficiently add new features -- such as SPARK, improved foundation heat transfer, detailed air flow modeling and atmospheric pollutant calculations -- that are planned for the first release of EnergyBase.

These modules will interact with an integrated heat-balance-based simulation that models the building, system, and plant simultaneously rather than in parallel. As a result, the effects of insufficient capacity in either the primary or secondary equipment will be noted as a deviation in space temperature outside of the desired design range rather than as an "unmet" load. In addition, sub-hourly time-steps will be possible.

EnergyBase will interface with new generalized input and output data files. These files will be structured with third-party interface developers in mind. Developers will be able to interface with the EnergyBase input and output format directly without relying on either the DOE–2 or BLAST files. Users of BLAST and DOE–2 will, however, be able to convert their input files to this new data structure, allowing them access to the EnergyBase simulation engine. It is expected that energy, economic, and pollution related output will be part of the initial phase of EnergyBase, while other results related to IAQ, thermal comfort, etc. are being considered as potential additions to the next phase of the project.

In conjunction with the modularity of EnergyBase, the new input and output data structures will give both engineers and software developers the flexibility to solve the many current challenges present in computer-aided energy analysis. These valuable features will also make EnergyBase a significant step toward the overall goal of producing a comprehensive, next generation building simulation tool.

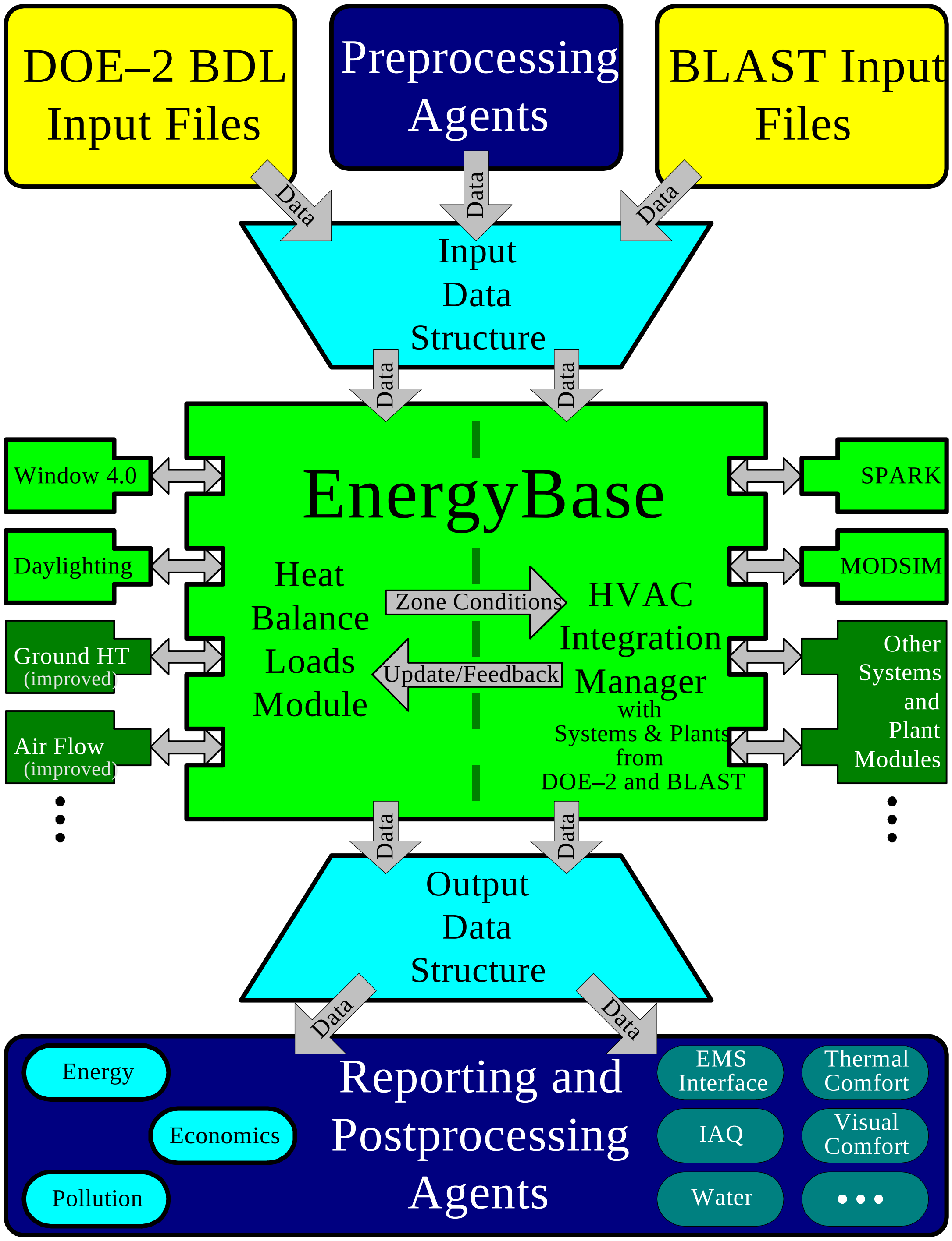


Figure 1: Schematic of the new EnergyBase program

The Use of Multiple Time-steps in IBLAST

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Introduction

Many different thermal processes occur within real buildings and each of these has its own characteristic response time. The challenge in designing a building simulation is to mimic the interactions of all the thermal processes and correctly duplicate their dynamic characteristics. Roughly speaking, the processes that occur within a building can be divided up according to whether they are effective on a long, intermediate, or short time-step. For example, slab floors and massive walls react on a characteristic time on the order of hours or even days, lighter building construction elements and large pieces of furniture may react on a characteristic time of tens of minutes, finally the zone air and system air loops react with times from a few tens of seconds to a few minutes. The simplest way to capture all these effects in a simulation would be to base the simulation time-step on the fastest acting process, i.e. the one with the shortest characteristic time. However, in practice this is usually undesirable because it results in excessive computation and, consequently, long program execution times. The alternative of a longer time-step to reduce execution time, results, at best, in a smoothing out of the dynamics of building thermal processes and, at worst, in instability of the simulation.

IBLAST Zone Temperature Update

IBLAST is a research version of the BLAST energy analysis program which simulates buildings, systems, and plants simultaneously rather than in parallel, allowing a more physical analysis of building thermal response and eliminating the difficult to interpret concept of "unmet" loads. In IBLAST, the zone air temperature is updated each time-step using an explicit finite difference method. In brief, this means that the zone air temperature at the current time-step is formulated in terms of quantities lagged by one or more time-steps and can therefore be solved without iterating on the zone heat balance; this was described in more detail in the Spring 1996 issue of the *User News.* The stability of finite difference methods in general, and the IBLAST method in particular, is sensitive to the time-step; typically, long time-steps result in an oscillating or divergent solution. When using IBLAST in a research setting it might be acceptable to have to "tweak" time-step parameters to obtain a good solution. However, for the program to be acceptable to all users, who may or may not have any background in working with finite-difference based simulations, a robust scheme is needed to automatically ensure stability.

IBLAST Multiple Time-step Scheme

After considerable analysis of the problem, and some trial and error, a way to set the time-step in IBLAST was found which mirrors the actual building physics and takes advantage of the fact that some building thermal processes occur slowly and some occur rapidly. In short, multiple time-steps are used to update building variables. In IBLAST, this means that there are two fundamental simulation time-steps: a long time-step for simulating interactions between the zones and the environment and a usually shorter time-step for simulating interactions between the zone air masses and the system air loops.

The process with the longest characteristic time is typically conduction, especially when there is a slab floor or other thermally massive constructions making up the walls, roofs or other building elements. In IBLAST, heat transfer through building surfaces is simulated using conduction transfer functions (CTFs). The CTF series for each zone surface and subsurface are calculated during program initialization for a specific time-step. This is the user specified time-step or, alternatively, the program default time-step of 15 minutes if the user does not specify a time-step. However, sometimes a stable CTF series cannot be generated at this time-step, and a longer time-step must be used. Interpolation of the inside and outside surface temperatures and flux histories is then necessary to obtain results at the desired time-step. Other heat transfer mechanisms affecting the building zones, such as interzone mixing, infiltration, and internal loads, are also updated at the user specified time-step.

The air in each zone is influenced by the net zone load and also by the output of the air handling system that heats or cools the zone. The difference between the net zone load and the heat supplied to or subtracted from the zone by the system is directly related to the rate at which the zone air temperature will change. If the difference is small, the temperature will change slowly. As the difference increases, the temperature changes more rapidly. It is this effect that has led to the use of a variable time-step to update the zone air temperature using the finite difference formulation of the zone energy balance. The point may be made that variability is not necessary so long as the selected time-step is short enough to always be able to accurately track the changes in zone temperature. However, using a constant short time-step would not be efficient in terms of program execution time. The important feature of a variable time-step is that it can be large, up to the value of the user specified time-step, when zone conditions are changing slowly, and decrease to accurately track rapidly changing zone conditions. In IBLAST, the minimum time-step used is one minute.

The fan systems and central plant are simulated within the variable time-step loop since the zone conditions are used to control the system output through the use of thermostat-like settings read from the input file. As a result, the systems and plant are simulated and updated every time-step of the simulation. But, the systems and plant themselves are assumed to be in quasi-steady operation so that the hot and chilled water loops can be solved iteratively.

Implications for EnergyBase

As implemented in IBLAST, the system described above works very well. The simulation can track rapid changes in zone conditions such as occur when the air handling system comes out of a setback period, and computations are reduced to the minimum necessary when zone conditions are relatively stable. The dual time-step method also has implications for EnergyBase (the merger of IBLAST and DOE-2) since it will use the IBLAST heat balance engine and build on the IBLAST and DOE-2 systems and plant simulation methods. One major implication is that most of the simulation results must be averaged to obtain output values representative of a whole hour. However, it may also be beneficial to have access to the output at the level of the shortest time-step since some building transients may only last for a fraction of a whole hour.

DOE-2 PROGRAM DOCUMENTATION

DOE-2 documentation is available from two sources.

- The National Technical Information Service offers a complete set of DOE-2 manuals, available for purchase separately; prices and ordering information are below.
- The Energy Science Technology Software Center at Oak Ridge, TN, offers the DOE-2.1E updated documentation (which includes the *Supplement*, *Sample Run Book, and BDL Summary)* free of charge when you purchase the mainframe or workstation version of DOE-2. See the "DOE-2 Directory of Program Related Software and Services" in this issue for ESTSC's address.

Also, many of the PC vendors of DOE-2 offer some or all of the documentation when you buy their program. Names and addresses of all DOE-2 vendors are found in the "DOE-2 Directory of Program Related Software and Services" in this issue.

To order any or all of the DOE-2 manuals from the National Technical Information Service:
National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161
Phone (703) 487-4650, FAX (703) 321-8547, http://www.fedworld.gov/ntis/home.html

Document Name	Order Number	Prices - 4/1/96	Foreign Prices
DOE-2 Basics Manual (2.1E)	DE-940-13165	49.00	
BDL Summary (2.1E)	DE-940-11217	28.00	Double
Sample Run Book (2.1E)	DE-940-11216	100.00	the
Reference Manual (2.1A)	LBL-8706, Rev.2	174.00	prices
Supplement (2.1E)	DE-940-11218	100.00	shown
Engineers Manual (2.1A) [algorithm descriptions]	DE-830-04575	57.00	at left

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